

VIDYASAGAR UNIVERSITY

Midnapore, West Bengal



PROPOSED CURRICULUM & SYLLABUS (DRAFT) OF

BACHELOR OF SCIENCE WITH PHYSICS (MULTIDISCIPLINARY STUDIES)

3-YEAR UNDERGRADUATE PROGRAMME
(w.e.f. Academic Year 2023-2024)

Based on

**Curriculum & Credit Framework for Undergraduate Programmes
(CCFUP), 2023 & NEP, 2020**

VIDYASAGAR UNIVERSITY, PASCHIM MIDNAPORE, WEST BENGAL

VIDYASAGAR UNIVERSITY
BACHELOR OF SCIENCE IN PHYSICSL SCIENCES with PHYSICS
(Under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks				
								CA	ESE	TOTAL		
B.Sc. in Physical Sc. with Physics	3 rd	V	SEMESTER-V									
			Major-A4	PHSPMJ04	T: Electricity & Magnetism; P: Practical <i>(To be studied by students taken Physics as Discipline- A)</i>	4	3-0-1	15	60	75		
			Major-A5	PHSPMJ05	T: Modern Physics; P: Practical <i>(To be studied by students taken Physics as Discipline- A)</i>	4	3-0-1	15	60	75		
			Major-A6	PHSPMJ06	T: Nuclear Physics; <i>(To be studied by students taken Physics. as Discipline- A)</i>	4	3-1-0	15	60	75		
			Major (Elective) -1	PHSMJE-02	T: Basic-Electronics; P: Practical <i>(To be studied by students taken Physics as Discipline- A)</i>	4	3-0-1	15	60	75		
			Minor-5 (Disc.-C5)	PHSMIN05	T: Digital-Electronics; P: Practical <i>(To be studied by students taken Physics as Discipline- C)</i>	4	3-0-1	15	60	75		
		Semester-V Total						20				375
		VI	SEMESTER-VI									
			Major-B4		<i>To be decided(Same as Major- A4 for Physics taken as Discipline-B)</i>	4	3-0-1	15	60	75		
			Major-B4		<i>To be decided(Same as Major-A5 for Physics taken as Discipline-B)</i>	4	3-0-1	15	60	75		
			Major-B4		<i>To be decided(Same as Major-A6 for Physics taken as Discipline-B)</i>	4	3-0-1	15	60	75		
			Major (Elective) -2	PHSMJE-02	T: Semiconductor-Device Phycs-Laser-Optical-Fiber; P: Practical <i>(To be studied by students taken Physics as Discipline- A)</i>	4	3-0-1	15	60	75		
			Minor -6 (Disc.-C6)	PHSMIN06	T: Analog-Electronics; P: Practical <i>(To be studied by students taken Physics as Discipline- C)</i>	4	3-0-1	15	60	75		
		Semester-VI Total						20				375
		TOTAL of YEAR-3						40	-	-	-	700
		Eligible to be awarded Bachelor of Science in Multidisciplinary Studies with Physics on Exit						126	Marks (Year: I+II+III)			2325

MJP = Major Programme (Multidisciplinary), MI = Minor, A/B = Choice of Major Discipline; C= Choice of Minor Discipline; CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

MAJOR (MJ)

Major A/B 4: Electricity & Magnetism

(Credits 04; Full Marks: 75)

MJ A4/B4T: Electricity & Magnetism (Theory) Credits 03 [45L]

1. Electrostatics

Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. Solutions of Laplace's equation, Potential and Electric Field of a dipole. Force and Torque on a dipole. Electric fields inside matter. Bound charges & Electric polarisation, Displacement vector, Linear dielectric medium, electric susceptibility and permittivity. [10L]

2. Magnetostatics

Definition of Magnetic Field, B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with an Electric Dipole: no derivation required). Ampere's Circuital Law and its application to (a) Solenoid, and (b) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (a) a point charge, (b) a current carrying wire, (c) between current elements. Torque on a current loop in a uniform Magnetic Field. [14L]

3. Magnetic Properties of Matter

Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis. [3L]

3. Electromagnetic induction

Non-conservative nature of electric field. Faraday's law of induction: simple examples (eg: motional emf, Faraday disc), Lenz's law. Self and mutual inductances in simple cases, L of single coil, M of two coils. Energy stored in inductors. [6L]

4. Maxwell's equations and EM waves:

Maxwell's equations, Equation of continuity of current, Displacement current, Poynting Theorem (Proof not required) & Poynting vector, Electromagnetic wave propagation through vacuum and isotropic dielectric medium, Transverse nature of EM waves, Wave impedance. [6L]

6. Alternating current

Mean and rms values of current and emf with sinusoidal wave form, reactance, impedance, power factor, Current and Voltages in LR, CR and series LCR circuits, vector diagram, resonance in a series LCR circuit, Q-factor. [6L]

Recommended Reading:

- Foundations of Electricity and Magnetism, B. Ghosh, 2008, Books & Allied Ltd; 3rd Revised edition
- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House
- Electricity and Magnetism, R. Murugesan, 2019, S. Chand
- Electricity and Magnetism, D Chattopadhyay and P C Rakshit, 2011, New Central Book Agency
- স্নাতক পদার্থবিদ্যা (সেমিস্টার II), দেবনারায়ণ জানা, সুজিত কুমার বেরা, এবং সীতারাম পাল, সঁতরা পাবলিকেশন।

Major A/B 4: Practical

(Credits 01; Marks: 20)

Major-A/B4 P: Electricity & Magnetism (Practical):

1. Determination of horizontal component of Earth's magnetic field using magnetometer.
2. Determination of low resistance of a sample wire using Carey Foster bridge.
3. To study the ac characteristics of a series RC circuit and calculation of capacitance from current reactance graph.
4. To draw the resonance curve of a series LCR circuit.
5. To study the variation (with current) of the magnetic field between pole pieces for different distances of an electromagnet using Gaussmeter.

Recommended Reading:

- Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
- Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Laboratory Manual of Physics, Vol. 1 & 2 Madhusudan Jana, Books & Allied (P) Ltd., 2022, Kolkata.
- Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
- B. Sc. Practical Physics, C. L. Arora, S Chand and Company Limited
- Physics in Laboratory, Mandal, Chowdhury, Das, Das, Santra Publication
- Advanced Practical Physics Vol 1 & 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher
- Practical Physics, P.R. Sasi Kumar, PHI Learning Private Limited
- B.Sc. Practical Physics, Harnem Singh, P.S. Hemne, S Chand and Company Limited

Major A/B5: Modern Physics

(Credits 04; Full Marks: 75)

MJ A5/B5T:

Modern Physics (Theory)

Credits 03 [45L]

Course contents:

1. **Atoms in Electric and Magnetic Fields:** Electron Spin and Spin Angular Momentum. Space Quantization. Larmor's Theorem. Electron Magnetic Moment and Magnetic Energy, Spin Magnetic Moment. Gyromagnetic Ratio and Bohr Magneton. Stern-Gerlach Experiment. Normal Zeeman Effect, Anomalous Zeeman Effect (Qualitative idea only). [8L]

2. **Quantum theory of radiation:** Failure of wave theory to explain Black body radiation, Planck's quantum hypothesis, Planck's radiation formula (statement only). Photo-electric effect. Compton effect. [4L]

3. **Basic Quantum Mechanics:** Wave nature of material particles, wave-particle duality, wavelength of de Broglie waves, Davission Germer experiment, Heisenberg uncertainty principle, Schrödinger equations: Time-dependent and Time-independent, Wave function and its probabilistic interpretation. Observables, Introduction to linear operators (Hermitian and Unitary). Eigen function & Eigen value, Expectation value, Calculation of various commutation relations. Probability current density, Particle in a one-dimensional infinite well: energy eigenvalues and eigen functions. Schrödinger equation for one-dimensional harmonic oscillator and energy eigenvalues (no detailed derivation required). [14L]

4. **Crystal structure:** Crystalline nature of solid, Miller indices, lattice planes, Interplanar spacing, Bravais Lattices, simple cubic, FCC and BCC lattices. Diffraction of X-ray, Bragg's law, Reciprocal Lattice. [6L]

5. **Crystal binding and Band structure:** Different types of bonding: ionic, covalent, metallic, Van der Waals and hydrogen. Elementary ideas about free electron theory (Fermi Sphere & Fermi Energy) and Band structure in conductors, direct and indirect semiconductors and insulators (qualitative discussions). [6L]

6. Elementary Lattice Dynamics

Elementary ideas about Lattice Vibrations and Phonon, Dispersion relation of a one-dimensional monoatomic lattice, Dulong and Petit's Law, Einstein Theory of specific heat of solids, and Debye T^3 law (derivation not required). [7L]

Recommended Reading:

1. Concepts of Modern Physics, Arthur Beiser, S. Mahajan, S Rai Choudhury, 2024, Medtech Science
2. Modern Physics, R. Murugesan and Sivaprasath Kiruthiga, 18th Ed., S. Chand.
3. Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, 2020, Tata McGraw-Hill.
4. Elements of Solid State Physics, J. P. Srivastava, 2014, PHI Learning Pvt. Ltd.
5. Solid State Physics, R. L. Singhal, P.A. Alvi, Kedar Nath Ram Nath
6. Quantum Mechanics, Jyotirmoy Guha, 2019, Books and Allied (P) Ltd

Major-A/B5: Practical

(Credits 01; Marks: 20)

Major A/B5 P: Modern Physics (Lab):

Course Outline:

1. Measurement of Planck's constant using three LEDs.
2. Determination of e/m of electrons by using a bar magnet.
3. To study the photoelectric effect: variation of photocurrent versus intensity and wavelength of light.
4. To show the tunnelling effect in tunnel diode using $I-V$ characteristics.
5. Verification of Stefan's law by using a glowing tungsten filament of a torch bulb.

Recommended Reading:

- Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
- Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Laboratory Manual of Physics, Vol. 1 & 2 Madhusudan Jana, Books & Allied (P) Ltd., 2022, Kolkata.
- Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
- B. Sc. Practical Physics, C. L. Arora, S Chand and Company Limited
- Physics in Laboratory, Mandal, Chowdhury, Das, Das, Santra Publication
- Advanced Practical Physics Vol 1 & 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher
- Practical Physics, P.R. Sasi Kumar, PHI Learning Private Limited
- B.Sc. Practical Physics, Harnem Singh, P.S. Hemne, S Chand and Company Limited

Major A/B6: Nuclear Physics

(Credits 04; Full Marks: 75)

MJ A6/B6 T:

Nuclear Physics (Theory)

Credits 04 [60L]

- 1. Bulk properties of nuclei and nuclear structure:** Nuclear charge, mass, size, mass defect, binding energy, binding fraction; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle; Properties of nuclear force, Stability and binding, B/A versus A graph, $N-Z$ plot. Nuclear models: Liquid Drop model, Nuclear shell model (qualitative discussions only) and magic numbers. [16L]
- 2. Unstable nuclei:**
 - (a). Radioactivity:** Survival equation, Half-life, Mean-life, Transient and secular equilibrium, radioactive dating. [3L]
 - (b). α –decay:** Alpha particle spectra – velocity and disintegration energy of α -particles, Range of α -particles, Geiger-Nuttal law. [4L]
 - (c). β –decay:** Detection of the β -energy, Nature of β -ray spectra, difficulties explaining the β -ray spectra, the neutrino hypothesis, energy levels & decay schemes, positron emission & electron capture. [6L]
 - (d). γ –decay:** Origin of γ -ray, γ -ray spectra & nuclear energy levels, γ -absorption in matter – photoelectric process, Compton scattering, $e^- - e^+$ pair production (qualitative discussions). [5L]
- 3. Nuclear Reactions:**
 - (a)** Types of nuclear reactions, Q value and threshold energy, nuclear reaction cross-sections, examples of different types of reactions and their characteristics, Bohr's postulate of compound nuclear reaction. [6L]
 - (b)** Nuclear fission and fusion: mass deficit and generation of energy, Reaction characteristics, explanation in terms of liquid drop model, fission products and energy release, spontaneous and induced fission, transuranic elements. [8L]
- 4. Cosmic ray:** Nature and origin of primary and secondary rays, latitude and altitude variations, hard & soft components, Cosmic Ray shower, Effect of Earth's magnetic fields. [5L]
- 5. Elementary particles:** Fundamental interactions in nature and their relative strengths, Elementary particles and their families. [4L]
- 6. Particle accelerators and detectors:** Linear Accelerator, Cyclotron, GM Counters. [3L]

Recommended Reading:

- Concepts of Modern Physics, Arthur Beiser, S. Mahajan, S Rai Choudhury, 2024, Medtech Science
- Nuclear Physics, D C Tayal, 2012, Himalaya Publishing House
- Nuclear Physics, S. N. Ghoshal, 1st edition, 2010, S. Chand Publication
- Modern Atomic and Nuclear Physics, A. B. Gupta, Books & Allied Pvt. Ltd.
- Schaum's Outline of College Physics, E. Hecht, 11th edition, 2009, McGraw Hill
- Nuclear Physics, An Introduction, S.B. Patel, 2018, New Age International

- Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Electronic Principles, A. Malvino, D.J. Bates, 7th Edition, 2018, Tata Mc-Graw Hill Education.
- Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI
- Microelectronic Devices & Circuits, David A.Bell, 5th Edn.,2015, Oxford University Press
- Basic Electronics: Principles and Applications, C.Saha, A.Halder, D.Ganguli, 1st Edition, 2018, Cambridge University Press
- Fundamentals Principles of Electronics, B. Ghosh, 2010, Books & Allied.

MJE-2P: Basic Electronics (Practical):

Credits 01 (30 Hrs.)

Practical:

1. To study the forward and reverse characteristics of a Zener diode and use it as a voltage regulator.
2. To study the static characteristics and the frequency response of the BJT amplifier in CE mode.
3. To study OP-AMP: inverting amplifier, non-inverting amplifier, adder, subtractor, integrator, differentiator.
4. Construction of OR, AND, and NOT gates using diode and transistors.
5. Construction of SR, D, JK, FF circuits using NAND gates.
6. Construction of a half adder and a full adder.

Recommended Reading:

- Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
- Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Physics in Laboratory (Semester III), Mandal, Chowdhury, Das, Das, Santra Publication.
- Laboratory Manual of Physics, Vol. 1 & 2 Madhusudan Jana, Books & Allied (P) Ltd., 2022, Kolkata.
- Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
- B. Sc. Practical Physics, C. L. Arora, S Chand and Company Limited
- Physics in Laboratory, Mandal, Chowdhury, Das, Das, Santra Publication
- Advanced Practical Physics Vol 1 & 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher
- Practical Physics, P.R. Sasi Kumar, PHI Learning Private Limited
- B.Sc. Practical Physics, Harnem Singh, P.S. Hemne, S Chand and Company Limited

OR

Major Elective (MJE)-3:

(Credits 04; FM: 75)

MJE-3T: Semiconductor Device Physics, Laser & Optical Fiber (Theory): Credits 03[45L]

1. Semiconductor Device Physics (32L)

1.1 Semiconductor Basics: Types of solids – conductors, semiconductors, and insulators, Crystal structure of Si and Ge, covalent bonding, Energy bands: valence band, conduction band, and band gap, Intrinsic and extrinsic semiconductors, concept of doping, Fermi level and its variation with temperature and doping, Carrier motion: drift and diffusion, mobility, and conductivity, Einstein relation between diffusion and mobility, Hall effect – determination of carrier type and mobility. (9L)

1.2 Carrier Dynamics and Recombination: Generation and recombination of electrons and holes, Radiative and non-radiative recombination (basic ideas), Carrier lifetime and diffusion length, Continuity equation in simple form, Photoconductivity and excess carrier decay. (5L)

1.3 PN Junction Diode: Depletion region and built-in potential, Energy-band diagrams at equilibrium and under bias, Ideal diode equation – qualitative derivation and interpretation, Forward and reverse characteristics of a diode, Drift and diffusion currents and their balance, Junction capacitance – depletion and diffusion types (concept only), Breakdown in diodes: Zener and avalanche (basic ideas), Temperature effect on diode performance. (9L)

1.4 Bipolar Junction Transistor: Modes of operation: cut-off, active, and saturation, Input and output characteristics of a transistor, Relation between α and β , concept of current gain, Simplified Ebers–Moll view and base transport idea, Early effect (concept only) and base-width modulation. (5L)

1.5 Optoelectronic Devices: Light-emitting diode (LED) – spontaneous emission and efficiency, Photodiodes – working principle and simple I–V characteristic, Solar cell – photovoltaic effect, I–V curve, and efficiency. (4L)

2. Laser: Stimulated emission and Laser, Laser resonator, population inversion, active and passive laser resonator, Threshold condition, saturation condition, Quality factor, Classification of laser: Three level laser and four level laser system (basic concepts only), Ruby laser, He-Ne laser, Application of laser. (8L)

3. Optical Fiber: Comparison with traditional communication systems, Core, cladding, and buffer layers, Total internal reflection and acceptance angle, Numerical aperture, Step-index and graded-index fibers, Single-mode and multimode fibers, Absorption and loss, Applications. (5L)

Recommended Reading:

- S. M. Sze & Kwok K. Ng, *Physics of Semiconductor Devices*
- Donald A. Neamen, *Semiconductor Physics and Devices*
- Ben G. Streetman & Sanjay Banerjee, *Solid State Electronic Devices*
- S. O. Kasap, *Principles of Electronic Materials and Devices*

- **Millman & Grabel**, *Microelectronics*
- **A. Ghatak & K. Thyagarajan**, *Lasers: Theory and Applications*, 2010, Springer Science
- **A. Ghatak & K. Thyagarajan**, *Introduction to Fiber Optics*, 2017, Cambridge University Press

MJE-3P: Semiconductor Device Physics, Laser & Optical Fiber (Practical): Credits 01 (30Hrs.)

Practical:

1. To determine beam divergence and spot size of a laser beam.
2. To determine the refractive index of the material of a prism using a laser source
3. To measure attenuation in an optical fiber
4. To measure the absorption spectrum of a coloured solution and determine its concentration using Beer-Lambert's law
5. I–V characteristics of Zener diode
6. Hall effect and Hall coefficient measurement
7. Photodiode / solar cell / LED I–V characteristics

Recommended Reading:

1. B.Sc. Practical Physics, C.L. Arora, 2010, S. Chand
2. Laboratory Manual of Physics, Vol 1 & 2, M. Jana, 2020, Books and Allied (P) Ltd
3. Practical Physics Vol 1 and Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publishers

MINOR (M)

(To be studied by students taken Physics as Discipline- C)

MI-5/C5: Same as Minor-5 (PHSMIN05) of Physics (Hons.) programme

Credits 04

Full Marks: 75

MI-6/C6: Same as Minor-6 (PHSMIN06) of Physics (Hons.) programme

Credits 04

Full Marks: 75